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Effect of Various Training Systems on Growth, Agro-Morphological Traits and Yield of Sponge Gourd (*Luffa cylindrica* (Roem)) L.

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ABSTRACT

Four training methods, namely the bower system (T_1), single plant training (T_2), netting (T_3), and ground trailing (T_4 check), were compared to study the effect of above ground training methods on the yield and morphological parameters of the sponge gourd. The pooled analysis of variance showed significant differences among all the treatments. The mean performance of yield and fruit morphological parameters revealed that maximum yield, fruits per plant, fruit length, fruit width and vine length were achieved in T_1, followed by T_3, T_2 and T_4. The average fruit weight was maximum in T_2, followed by T_1, T_3 and T_4. The percent increase in yield of T_1, T_3, and T_2 over T_4 (check) was 7.88, 71.36 and 29.81%, respectively. The study of inter-association among the traits revealed that yield per hectare showed significant positive correlation with fruits per plant, fruit length, fruit width and average fruit of the weight, suggesting an increase in yield with the increase in value of these traits. Hence, training of vines on above-ground structures improves morphological parameters of fruit as well as total yield.

Keywords Sponge gourd, Training, Correlation, Morphological parameters, Yield.

INTRODUCTION

Sponge gourd is a minor vegetable crop mostly grown for its nutritious tender fruits. It belongs to family Cucurbitaceae and is supposed to be originated in subtropical Asian region particularly India (Swarup 2006). The fruits are nutritious with high medicinal value. Fresh fruit of 100 g weight contain 93.2 g moisture, 1.2 g protein, 0.20 g fat, 2.9 g carbohydrate, vitamins (120 mg carotene, 0.02 mg thiamine, 0.06 mg riboflavin and 0.4 mg niacin), minerals (36 mg calcium, 19 mg phosphorus and 1.1 mg iron) and 2 g fiber (Dhaliwal 2012). It contains more protein and carotene than ridge gourd (Gopalan *et al.* 1999).

Cucurbits are grown in almost all the parts of the world. However, China, Korea, India, Japan, Nepal and Central America are the top cucurbits producing countries. In India, top cucurbits growing states are Uttar Pradesh, Punjab, Bihar, Gujarat, Rajasthan, Jharkhand, Haryana and Karnataka. Sponge gourd, being a minor crop is grown in scattered areas, therefore exact area and production statistics are not available. The mature fruits provide luffin A and luffin B which are important antioxidants and improve health. The fruits are considered good for rheumatic

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and arthritis sufferers. It also maintains blood pressure by improving blood circulation.

In cucurbitaceous crops, management of plant canopy architecture though training and pruning can play a key role in increasing marketable yields. Training of a plant increases its capacity to receive the sunlight it needs to thrive (Kosson and Dobrzanska 2002, Shirahmadi *et al*. 2017), and proper air circulation around the plant lowers the chance of insect and fungal issues (Kosson and Dobrzanska 2002). Production of most of the sponge gourd in India is mainly restricted to ground trailing of the plants. However, biotic and abiotic stresses are the main factor responsible for low yield and poor quality of fruits under this system. Luxuriant growth of plants, prolonged harvesting, greater yields, improved pest management, straighter fruits and greater number of plants per acre due to closer rows are major advantages of different training methods used in cucurbit crops. Therefore, the current study aims to propose the direction of future sponge gourd production technology by considering attractive cultivation methods for maximizing productivity.

MATERIALS AND METHODS

The experiment was conducted at PAU-Regional Research Station, Ballowal Saunkhri, Balachaur, SBS Nagar during January-July for two consecutive years 2021-2022. Four different training methods, namely bower system (T_1), single plant training (T_2), netting (T_3) and ground trailing (T_4) were evaluated using sponge gourd variety Punjab Nikhar under Randomized Block Design (RBD) in three replications. The nursery of sponge gourd was sown under protected structures in January, using protrays containing cocopeat, vermiculite and perlite in a 3:1:1 ratio as growing media. Transplanting was done in first fortnight of March on 3 meter-wide raised beds. The planting of seedlings was done at 80 cm apart from each other on both the edges of raised bed. The crop was raised as per the package of practices of Punjab Agricultural University, Ludhiana. Each treatment has 10 plants (5 on each edge of the bed) in all the replications, and data were recorded from five plants. The data were recorded for days to first picking (DFP), number of fruits per plant (FPP), fruit length (FL), fruit width (FW), average fruit weight (AFW), vine length (VL) and yield per hectare (YPH). For each treatment, data from three replications was used in all statistical analyses. To estimate the existence of treatment × environment interactions pooled ANOVA was performed. The pooled analysis of variance and pearson correlation was performed using package developed by Sheoran *et al.* (1998). Seasonal abundance of blister beetle (*Mylabris pustulata*) in ash gourd was also recorded.

RESULTS AND DISCUSSION

Analysis of variance

The pooled analysis of variance showed significant differences among treatments for almost all the traits viz., DFP, FPP, FW, AFW, VL and YPH (Table 1), which revealed the presence of sufficient variations among all the treatments. Similar results were shown by Bhanuprakash *et al.* (2021) while studying performance of bitter gourd in different training systems. The significance of year and treatment for VL and YPH suggested that there were variations in the mean value of these traits across treatments as well as between years. This variation may be due to the difference in prevailing environmental conditions during both the years.

Mean performance

The mean performance of different morphological and yield traits of sponge gourd pooled for two consecutive years under different systems of training is presented (Table 2). DFP is an important trait from farmer's point of view, as the produce reaching early in the market fetches higher prices. The value of DFP varied from 54.83 (T_1) to 63.33 (T_4), revealing superiority of all the treatments over check (T_4) (Table 2). This suggested that training of vines over some structures can lead to early picking of the fruit. Training of vines on certain structures lead to early harvest of cucumber was reported earlier also (Kapuriya *et al.* 2017, Rajalingam *et al*. 2017). This may be due to ease in pollination of the flowers by honey bee as the flowers in case of training structures remain exposed and can be easily visited by the pollinating agents. While on the other side in ground

Table 1. Pooled analysis of variance for different traits of sponge gourd grown under different systems of training. *Significant at 5% level.

Source	DF	DFP	FPP	FL	FW	AFW	VL	YPH
Year (Y)	1	0.167	6.00	2.85	0.003	69.165	1610.47*	647.64*
Replication	4	5.542	1.95	1.76	0.039	1247.76	12.14	33.76
Treatment (T)	3	89.00*	148.33*	26.03	0.156*	564.16*	7385.36*	9134.03*
Y × T	3	7.16	1.88	4.66	0.003	17.48	36.67	34.15
Error	12	12.54	3.23	1.43	0.053	56.69	69.27	107.44

trailing (T_4) the flowers remain hidden below the vines leading to less exposure of flower and delayed pollination. Contrastingly, Shivaraj *et al.* (2020) reported no significant effect of different training systems on days taken to first harvest of cucumber.

Fruits per plant has a great significance from commercial point of view as it directly contributes to yield per unit area. For FPP, the value of mean varied from 12.83 (T_4) to 24.16 (T_1). The maximum FPP were found in treatment T_1 (bower system). These results are in line with Jadhav *et al.* (2023) and Rajalingam *et al.* (2017) who have reported increased number of fruits in cucumber under different training systems. This may be due to the proper growth of vines over the bower and increased fruit set due to exposure of female flower to pollinators.

For FL, FW, AFW all the treatments T_1, T_2 and T_3 were superior to the check treatment. The maximum FL and FW was achieved in treatment T_1 while maximum AFW was found in treatment T_2. The increase in fruit morphological parameters were reported earlier also (Kapuriya *et al.* 2017, Rajalingam *et al.* 2017, Shivaraj *et al.* 2020, Bhanuprakash *et al.* 2021). The increased mean of fruit morphological parameters in various training systems may be due to availability of enough space for proper development of shape and size of the fruit. Contrastingly, in ground training the shape and size of the fruit are not properly developed due to lack of space for the growth of fruit. Moreover, it was also observed during the research trials that the fruits in all the above ground training systems were straight and uniformly thickened throughout the length of the fruit (Fig. 1). These types of fruits fetch good prices in the market and also liked by the consumers. While in ground trailing, curved fruits were formed, which have less demand in the market.

Vine length is considered as an important yield contributing trait, because it leads to a greater number of nodes, branches and flowers, ultimately results in increased productivity. The maximum vine length was achieved in T_1 followed by T_4, T_2 and T_3. Increase in vine length in different training structures is reported by other researchers also (Kapuriya *et al.* 2017, Rajalingam *et al.* 2017, Shivaraj *et al.* 2020, Bhanuprakash *et al.* 2021). Here also the availability of adequate sunlight and proper space for spread of the vines in bower system may be considered as the reason for increased vine length in T_1.

Increased yield per hectare is the main goal of any research. The maximum yield per hectare was achieved in T_1 followed by T_3, T_2 and T_4. The percent increase in yield of T_1, T_3 and T_2 over T_4 (check) was 77.88, 71.36 and 29.81%, respectively.

Table 2. Pooled mean of different morphological traits under different systems of training in sponge gourd.

Treatment	DFP	FPP	FL	FW	AFW	VL	YPH
T_1	54.83	24.16	25.33	2.32	126.29	575.30	194.82
T_2	55.83	19.33	24.62	2.17	128.87	507.14	153.13
T_3	56.66	22.33	24.99	2.25	124.43	497.58	187.68
T_4 (check)	63.33	12.83	20.85	1.95	107.48	515.14	109.52
LSD	4.67	2.39	3.77	0.097	7.29	10.56	10.20

Fig. 1. Appearance of fruits in above ground training system and ground trailing.
(A) Uniformly thickened less curved fruits in above ground training system,
(B) Curved and uneven thick fruits in ground trailing.

The increase in yield under various training system in different crops were also reported (Kapuriya *et al.* 2017, Rajalingam *et al.* 2017, Shivaraj *et al.* 2020, Bhanuprakash *et al.* 2021). The credit of increased yield in the above ground training methods can be given to increased vegetative growth, increased fruit set and good shape and size of the fruit. This is due to proper penetration of sunlight and air between the vines and improved pollination due to exposed flowers.

Pearson correlation

The trait YPH revealed significant positive correlation with FPP, FL, FW and AFW (Table 3), suggesting increase in yield with the increase in value of these traits. Similar results were shown by Kumar *et al.* (2013) in sponge gourd. Similarly, FL, FW and AFW also showed positive association with fruits per plant. FL also showed positive significant association with AFW, suggesting increase in the weight of fruit with increase in its length. The trait DFP revealed negative significant association with FPP, FL, FW and YPH, suggesting decrease in the value of these traits with the increase in number of days to first picking.

Insect-pest data

During the experiment, adults of blister beetle, *M. pustulata* (Thunberg) were observed feeding on the

Table 3. Pooled correlation analysis among yield and other morphological traits in sponge gourd. *Significant at 5% level. **Significant at 1% level.

	DFP	FPP	FL	FW	AFW	VL	YPH
DFP	1.000						
FPP	-0.765**	1.000					
FL	-0.614**	0.689**	1.000				
FW	-0.520**	0.655**	0.355	1.000			
AFW	-0.403	0.417*	0.507*	0.318	1.000		
VL	-0.249	0.392	0.199	0.209	0.114	1.000	
YPH	-0.701**	0.955**	0.709**	0.554**	0.408*	0.383	1.000

Table 4. Seasonal abundance of *Mylabris pustulata* in ashgourd.

SMW	Mean population of *M. pustulata* / plant (avg of 5 plants)
9	0.10 ± 0.07
10	0.80 ± 0.13
11	1.40 ± 0.16
12	2.40 ± 0.16
13	4.60 ± 0.34
14	3.00 ± 0.21
15	1.60 ± 0.16
16	1.80 ± 0.39
17	0.60 ± 0.16
Mean ± SE	2.32 ± 0.17

flowers and buds of the ash gourd plant. Data on the seasonal occurrence of *M. pustulata* on ash gourd, covering the period from Standard Meteorological Week (SMW) 9 to 17, is given (Table 4). The initial presence of *M. pustulata* beetles on ash gourd flowers was recorded in the first week of March, with a subsequent increase in their incidence. The average weekly incidence of *M. pustulata* during the crop season was 2.32 ± 0.17 beetles per plant (Table 4). Incidence reached its peak during SMW 13, after which it began to decline. Sharma and Singh (2018) previously observed *M. pustulata* infesting the flowers and buds of cucurbits viz. cucurbits viz. *Luffa acutangular* (4.16 – 4.38 beetles per plant), *Cucurbita maxima* (4.18 – 4.56 beetles per plant) and *Laginaria vulgaris* (2.34 – 2.76 beetles per plant) in the sub-mountainous regions of Punjab. *M. pustulata* is known to feed on the flowers, buds and tender growth of cucurbits, malvaceous plants, pulses, beans, potato, flax, sunhemp, sandalwood, mustard, maize, groundnut, blackgram, chrysanthemum, eggplant and okra, as documented across various parts of India and specifically in Punjab (Shende *et al.* 2013, Taggar *et al.* 2015, Raju *et al.* 2016, Brice *et al.* 2017, Nair *et al.* 2017).

CONCLUSION

Training and pruning are crucial practices to enhance the quality of fruit and yield potential of cucurbitaceous crops. Sponge gourd is an important crop cultivated for its tender fruits, which are used for culinary purposes. Mostly, sponge gourd is cultivated by using the ground trailing method (vines are left to spread on the ground). In this method, the yield is less and the shape and size of the fruit are also distorted. Therefore, four training methods, namely the bower system, single plant training, netting and ground trailing, were compared to study the effect of training methods on sponge gourd yield and quality of the fruits. Maximum yield and fruit morphology parameters were found in the bower system, followed by netting, single plant training, and ground trailing. The external appearance and morphology of the fruit were better in all the above-ground training methods. Contrastingly, the fruits were not uniform and curved in the ground trailing method. These types of fruits fetch less in the market and are not liked by the consumers. Hence, training of sponge gourd on above-ground structures increases its yield and improves the appearance of the fruit. This may be because of the proper penetration of light and air and the better spread of the vines over the training structures. Moreover, the exposed flowers in above-ground training methods are easily pollinated by the pollinating agents.

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